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MINUTES OF EVIDENCE
TAKEN BEFORE THE

SELECT COMMITTEE ON SCIENCE AND TECHNOLOGY

(SUB-COMMITTEE II)

Thursday 22 November 1990

SCIENCE POLICY RESEARCH UNIT

Mrs M L Sharp, Mr K Guy and Mr B R Martin

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THURSDAY 22 NOVEMBER 1990

Present:

Carver, L. (Chairman)	Nelson of Stafford, L.
Dainton, L.	Nicol, B.
Flowers, L.	Shackleton, L.
Kirkwood, L.	Sherfield, L.
Lewis of Newnham, L.	

Examination of Witnesses

Mrs M L Sharp, Leader, DRC Innovation Group, Mr Ken Guy, Leader, Evaluation of Government and Industry Strategies for Technology Group, and Mr Ben R Martin, Leader, Science Policy and Research Evaluation Group, Science Policy Research Unit, called in and examined.

Chairman

530. Good afternoon, Mrs Sharp. We are very grateful to you and your colleagues for coming to give evidence to us this afternoon. You can see from our name plates who we are, but you may not know our specialist advisers Professor Roger Williams and Dr Mick Lomer. If you would like to introduce yourselves and make any opening statement about the subject generally we would be grateful if you would do so.

(Mrs Sharp) Thank you very much, my Lord Chairman. Can I say how grateful we are to you for asking us here. I am Margaret Sharp, and I am the Senior Research Fellow at the Science Policy Research Unit. My own field of specialisation has been on technology rather than on science policy. I have done a certain amount of work, as far as the UK is concerned, in looking at collaboration in science, but have not done any specific work looking at international collaboration at the nitty-gritty coalface level, but quite a lot of work looking at what has been happening in Europe. On my right is Ken Guy—he will introduce himself—and on my left is Ben Martin, who are both Senior Research Fellows at our institute. We would like to start by making three points in relation to your brief. First of all, as I think you yourselves are probably very well aware by now from the work you have done looking at the issue of international collaboration, we would stress that collaboration, comes in all sizes, shapes and varieties. Our own feelings are that the best collaborations are those that grow naturally from underneath, rather than those that are forced. It is, therefore, very important to look not just at the multi-national collaborations, which I think are the focus of what you are looking at at the moment, but to think also about bi-national collaborations which can sometimes be very important and, for that matter, the whole process of collaboration and networking within one country. One needs to consider at the whole range of collaborations when one is looking at this issue. Secondly, I think it is important that, in looking at this issue of international collaboration, to recognise that many of the collaborations that exist have grown out of what have been fairly deep cultural roots that have grown over the course of time. If you look at the spatial pattern of collaborations they often reflect old cultural and geo-political links. What we feel is important here to stress that governments cannot create collaborations; they do better to build on nurture those links that are promising. Sometimes, rather than trying to force multi-national collaboration, either national collaboration (that is collaboration within a national framework) or even bi-national collaboration may be just as good as trying to force the pace in terms of multi-national collaborations. Lastly, we think it is important to stress the fact that we do not see collaboration as a zero sum gain. Sometimes some of the writings on this issue have indicated there are gains for some and losses for others. Good collaborations should actually end up with there being many gainers. We think it can be so and that is wrong to look at it as a zero sum gain.

Having said that, I would like to pass over, if I may, to my colleague, Ken Guy, just for him briefly to introduce himself, and then Ben Martin will do the same.

(Mr Guy) As Margaret has said, I am a Senior Fellow at the Science Policy Research Unit. Over the past decade or so my main interest has been in the evaluation of Government technology programmes rather than science programmes, particularly collaborative R&D programmes. Since the early 1980s, in conjunction with a group at Manchester University, we have been evaluating the Alvey programme in information technology in this country, and are currently evaluating the Swedish programme of a similar nature, the Joint Council Cognitive Science and Human Computer Interation Initiative in this country, and also advising the European Court of Auditors on their evaluation of the Esprit programme, the international collaborative R&D programme. I would like to make one point which perhaps Margaret did not touch on in her opening remarks: I would like to know if your remit extends to looking at technology programmes as well as science programmes. I do not think nowadays we can consider international science programmes in isolation from international technology programmes, given developments over the 1980s.

(Mr Martin) I am Ben Martin and I work in the group called Science Policy and Research Evaluation within SPRU, and this is the group concerned primarily with policies for the more basic sciences as opposed to technology and innovation, which is the bulk of SPRU's work. Our studies, which have been going on now for 10 or 12 years, have involved evaluation of one form or another, looking at scientific outputs from, in particular, big science laboratories, and in the course of that we were involved in looking at a particular example of an

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[Chairman *Contd*]

international scientific programme, namely the CERN particle physics laboratory. There are some lessons which come from that study which relate to some of the questions you sent us.

531. A good deal of the evidence we have received has suggested that as a nation we do not handle international collaboration in science as well as some other countries, notably France and Germany. I wonder if you have views about whether that is a valid criticism? It has centred a certain amount on the long time it takes to get an answer out of the governmental machine as to whether an international collaborative programme is going to be supported or not. On the other hand, we are very seldom seen to initiate these programmes ourselves, we wait until somebody else has and then wonder whether we will join or not. Do you think those criticisms are valid?

(Mr Martin) One of the differences between Britain and the two other countries you mentioned, France and Germany, is that they do have a slightly more centralised approach to international collaboration. In France it is channelled through the Ministry of Research and Technology (although it is the Ministry of Foreign Affairs which actually pays the international subscriptions), and likewise in Germany it is the BMFT which plays a central role. In Britain we have a much more decentralised decision-making process which does add to the delays and complications, and maybe that accounts for British scientists being a little less enthusiastic about setting plans for international scientific programmes in motion. But this may get into the argument about whether a Ministry for Science or some cross-cutting agency for science and technology, not necessarily of ministerial status, should be developed in Britain. I am not sure that is an argument you want to get into here. It is certainly a problem we have encountered with some of these examples of international scientific programmes.

532. Do you think, therefore, a degree of criticism is valid?

(Mr Martin) I think it is. I think part of the problem, you see, is that at present we have no option but to make decisions on a field by field basis. The scientists in one community will come up with a proposal which will go to their research council and there will be a yes or no decision. We have no way of making trade-offs across fields, as you can do if at some point in the machinery everything is brought together. I think they do do an element of that in France and Germany and we are missing out to some extent there.

Lord Flowers

533. Without wishing to push you into a full blooded discussion of minister or not minister, is it your opinion, yes or no, that if we had a Minister for Science with some central responsibilities for getting policies agreed to we would be able to handle international scientific policies better?

(Mr Martin) A simple answer, yes, although it would take much longer to justify. I think there would be benefits.

Lord Nelson of Stafford

534. What is the role of SPRU in relation to international collaborative programmes?

(Mr Guy) We sometimes act as evaluators of such programmes. We sometimes act in the role of advisers.

535. On behalf of?

(Mr Guy) Various government departments or, for example, the Commission.

536. But only sometimes?

(Mr Guy) Not invariably, there is competition.

537. When they think it is desirable, or when you think it is desirable?

(Mr Guy) A little bit of both!

(Mrs Sharp) We also hold a general watching brief over what is going on both in Europe and internationally in science policy, and in this sense part of our role at SPRU is to maintain a capability to critique what is happening internationally. In that sense we do try to get involved in evaluation procedures because the experience is very useful from the point of view of acquiring knowledge and competence.

538. This is important because one of the weaknesses that seems to come out is that there does not seem to be any oversight of our international activities. It is all rather ad hoc according to individuals or departments?

(Mrs Sharp) Yes, I think this comes back to the point Ben made, because responsibilities are split, and often split not just between the DTI and Education and Science but often in the agricultural programmes, with MAFF, and health programmes with the Department of Health. You have got split responsibilities here. Whereas in countries such as France and Germany, where there is a single ministry for science and technology, it is an easier process to co-ordinate activities.

Lord Flowers

539. But it is true so far as SPRU is concerned, is it not, that your core funding is not sufficiently adequate? You can set yourselves up as a general critic of international programmes but you have to wait for somebody to ask you to do something and offer to fund you?

(Mrs Sharp) Yes. Roughly 75 per cent. of our funding comes from contract research, and 25 per cent. is UFC funding and paid for by teaching

[Lord Flowers *Contd*]

activities. Amongst that 75 per cent. is a degree of core funding from the ESRC but that amounts to rather less than 10 per cent. The answer is that we try to keep a general watching brief but in order to do so we actually need to be able to take on contracts which feed our stock of knowledge.

540. I should confess that some years ago now I told their Vice Chancellor that he ought to spend more on core funding of SPRU, but I do not know whether he ever did.

(Mrs Sharp) We have seen some increases!

Chairman

541. The body which is supposed to be providing this co-ordinating and overall look as far as major programmes are concerned is the Science and Technology Secretariat in the Cabinet Office under the Chief Scientist, with whom no doubt you have fairly close links?

(Mrs Sharp) Yes.

542. Do you get the impression that it is doing the job it is supposed to be doing well, or that there is a failure in that area?

(Mrs Sharp) Perhaps I can come in on that briefly. It seems to me that there are two problems that it faces. One is resources. It is actually substantially under-resourced for keeping any major watching brief. Secondly, it has only been taking this broad watching brief it has for about two years, since the re-organisation into ACOST from the old ACARD. Admittedly, ACARD took a certain number of subjects and then looked in detail at those, but it did not maintain a watching brief. There has been an international committee of ACOST of which our Director, Geoff Oldham, is the chairman. That has only been at work for the last two years and, therefore, has not really had time to get to grips with this sort of issue. The problem of under-resourcing is a fundamental one.

543. What part do you see ABRC playing in all this?

(Mrs Sharp) In time maybe ABRC could play a more substantial role but, once again, we have seen re-organisation, with more substantial executive powers being given to ABRC in the last year. It has yet to grow into that role. The problem I think of co-ordinating the research councils within the national framework, let alone to do it at an international level, is one it is still grappling with.

544. Perhaps we could turn to the question of the balance between national and international programmes. Certainly in other studies we have done you tend to say to us that it is important to go into an international programme because you could not afford the resources to go into it on your own. Then you are also told that it is terribly important if you are going into an international programme to have strong national programmes. It is obviously a balance in resources between the two. Would you like to make some comments on that issue. CERN, for instance, does not have a national programme. In fact, CERN is our national programme in that field. In certain other fields all our international collaboration comes from our national programme. Is there some principle which ought to guide us on this?

(Mr Martin) CERN is an interesting example, although probably a rather extreme one, in terms of costs and degree of centralisation. When CERN was established there were at that stage quite well developed national programmes in Britain, France, Germany and Italy, and CERN was put forward largely in terms of cost sharing; that by doing things jointly we could build accelerators on the same scale as the Americans, which were at that stage too expensive even for the richer members of Europe to afford. A few years after that the people involved with CERN began to put forward very ambitious plans for expanding the national programmes, the argument being that you needed a triangle of effort, with CERN at the top and strong national programmes. Some of these plans involved doubling or tripling the size of the national effort but that was quickly squashed by some of the governments who said, "Well, you can't on the one hand tell us this is going to lead to cost savings and then a few years later come back and say you want ambitious national programmes". With the exception of Germany, those national programmes have now largely withered away. There you have an example of a highly successful scientific programme operating largely in the absence of a national experimental programme. There are national theoretical efforts and there are obviously experimenters in British universities but they go off to CERN or the German or American laboratories to do their experiments. You clearly can have an international programme with very little in the way of a national operation.

Lord Lewis of Newnham

545. Do you see any difficulties with this particular procedure whereby all the work now must be done, if I understand it correctly, in CERN?

(Mr Martin) Not quite all,—there are one or two alternatives. CERN is the main option but British experimentalists in this field can also go to the German national laboratory which is, in fact, open to outside countries, or they can go to one of the American laboratories. There are various options around. There are certain problems here, one of these (and this relates to one of your questions about the role of peer review) is that peer review has worked very successfully in the 20 or 30 years since the end of the second world war. It works well when you have lots of small groups competing for funds. If one group is asked to comment upon the proposal from another group it makes very little difference whether they say yes or no to their own chances of

[Lord Lewis of Newnham *Contd*]

getting funds. In a big science like high energy physics, who do you go to for your neutral peers? Most of them will either be using CERN, and if it is a proposal from CERN they will say, "This is a good idea", or they are a user of a rival laboratory who might therefore benefit if there is more money left in the pot by turning down this particular proposal. Certainly it causes problems in relation to the peer review process if that is your main mechanism for making decisions on these international programmes.

Lord Flowers] Could I just make a comment? Mr Martin knows the CERN operations very well indeed, and I am sure he did not mean to mislead us in any way but it is of course perfectly true that, with the exception of Germany, there are in Europe only international machines. These are machines at which national groups mount programmes in an international framework, very often with teams from other countries as partners, but it would be quite incorrect to give the impression there is no national effort going into it. The amount of British money spent in this country on the mounting of experiments at CERN and on their analysis thereafter and all of that is huge. It is not just an international programme and nothing else, by any means.

Lord Dainton

546. And it is quite widely distributed between, on the one hand, the Rutherford-Appleton laboratory and universities like Liverpool.

(Mr Martin) My point is that those national expenditures would not operate if CERN were to be closed tomorrow; they are on the back of the CERN programme; they are part of that international effort.

547. Or on the back of LEP?

(Mr Martin) There are another two or three laboratories which are open to British scientists in this field.

Lord Lewis of Newnham

548. This was the point I was trying to get to. If we were to take your model you imply that all the work was done at CERN and very little done over here. If one looks at Germany and France and compare this with the UK, and the actual mounting of programmes; if I understand you correctly, it is much easier in France and Germany because people are not necessarily committed to university lecturing programmes. In the UK in contrast it would require very much more time being spent at the particular site with teaching problems in the respective university. Do you see any problems with this area?

(Mr Martin) I am not sure of the current situation. The study we did was a few years ago. I know one change which has taken place since then has been a big expansion in the number of contract researchers—post-doctoral fellows—in British universities, so it is possible that the problem may now be less severe because those people do not have a teaching commitment like tenured or permanent university faculty.

Lord Dainton

549. It is very demanding if you are in a physics department and involved in a big experiment and one has to constantly go to other places, at other people's convenience, and it does interfere with the teaching at your own university, but by and large the nuclear physics industry have coped with this and the concentration of nuclear physics has helped to make that possible. Is that fair comment?

(Mr Martin) Yes, I think it is. I was not giving this example as advocating this should be a model for everything—I was saying this is an extreme case. Our main position is that there are many different models of international collaboration, of which CERN represents one, and one which in my view is a highly successful centre but which took 15 or 20 years to learn how to operate efficiently. The DESY laboratory in Germany, which is essentially one country providing a host site for outside visitors from many other countries, learnt how to operate efficiently rather more quickly. One of the things which came out of our study of CERN is that throughout the '60s and '70s, when there was a number of major discoveries in the field, all but one of them was made in the States on very similar machines; and when we asked the researchers the reasons for it, they pointed to the difficulties of learning how to operate a facility where there are a dozen member states all wanting to be represented on the committees, and those committees taking a rather longer time to process proposals and making rather more conservative decisions. And there were specific examples where a proposal did not get through the CERN system but did get through the American system which was more flexible. It was only after 15 or 20 years they learnt how to do this effectively and at that stage began to make more bold, risky decisions, such as the one to close down the new Super Proton Synchrotron, sacrificing a year's experimentation, and set up the proton antiproton collider, which at the time was regarded as a very risky decision but which actually paid off.

Chairman

550. Is it not a mistake to think of national programmes and participating in international programmes separately, competing with each other? Are we chasing a hare here? That in fact one's participation in an international programme is in fact part of one's national programme?

(Mrs Sharp) Yes, I think that would be the right way to look at it, and it is very important to recognise the complementarities here. In fact in order to get the most out of collaboration you actually have to have a fairly strong programme to help to assimilate the fruits of that collaboration.

[Chairman *Contd*]

551. Certainly when we were studying space and also more recently in the field of astronomy, it was suggested to us there is not a strong enough national programme to back our participation in the international ones, and this therefore is a form of brain-drain—we are subsidising in a way the other people. Is that a valid point of view?

(Mr Martin) In the case of astronomy, I believe the next speaker will be talking about that. It is an interesting case because for many years British astronomers largely preferred to operate a national programme rather than an international one. For example, Britain did not become one of the original members of the European Southern Observatory. They did enter into a joint approach with Australia but did not get involved in the multinational collaboration within Europe. The interesting thing is that during that period, there were some very prominent and capable observational astronomers who got fed up with the national programme and limited facilities, the biggest of which was the Isaac Newton telescope in Sussex, and went off to the United States where many of them have since stayed. In other words, there was a brain-drain going on which might have been less pronounced if we had become plugged into the international collaboration at an earlier stage.

(Mrs Sharp) It is very important to see international collaboration as being part of the cross-fertilisation of ideas which comes in science anyhow, from the mixing of communities and this sort of thing. In that sense we would be very much the poorer if we did not participate in some of these programmes. On the issue of the brain-drain, there are other factors affecting it, which will be there anyhow, irrespective of the international programmes.

Lord Kirkwood

552. Is there evidence of a brain-drain to Europe as a result of salary differentials or because of a viable base not being established in this country?

(Mr Guy) There are some signs in areas like information technology of us starting to get the beginnings of a drain of R&D people. It reflects more the crumbling of the industrial base in this country rather than anything else.

(Mrs Sharp) In biotechnology, which is the field I know more about, there is some evidence that a number of laboratories which have been set up in France, where they do not have a sufficient number of trained people internally to man their laboratories, are pulling in a very large number of Britons. I think we would expect to see that with the coming of 1992; mobility is going to increase.

553. Is that the attraction of the facilities which are available or are these salary differentials?

(Mrs Sharp) I think it is the there things: facilities, salaries and the type of post—very the frequently offered do not involve teaching and administrative responsibilities which people in universities currently have to bear.

Lord Dainton

554. You did mention right at the beginning you saw the best kind of collaboration is that which is in a sense self-chosen by the working scientists. Bottom-up. That is a free association?

(Mrs Sharp) Yes.

555. It hardly forms part of a programme but may take advantage of, for example, the Framework Programme, that sort of thing. Leaving that out of consideration, I would like to put it aside and turn to these larger programmes.

I would like to know whether you think it is true and whether there are any real differences between them. There are two other different kinds of programmes, one is represented archetypally by CERN, where the programme itself is predetermined by international discussion, as well as by international subscriptions, and then there are other places like ILL in which they are set up internationally but the work that is done is very often determined by scientists from their own individual countries doing what they want; they are a kind of research hotel. Is there any difference in performance between the two? Finally, are there different ways in which these should be managed that we should know about?

(Mrs Sharp) I personally do not know enough about these two different styles to answer that question. Ben, do you have any views on this?

(Mr Martin) Only to a limited extent because I am not sufficiently familiar with ILL. There was one occasion, and this relates to the question which came up earlier, when we were approached in a very tentative manner about possibly looking at ILL and evaluating how well that was performing scientifically and otherwise, but that never came to anything. I think you have perhaps slightly exaggerated the difference between the two, in that CERN is not completely a laboratory with a centrally determined research programme. They are still responding to the individual proposals from groups of researchers and a policy emerges by choosing some of these and not others and combining some and so on.

556. You would agree that a lot of work is now pre-determined for years ahead because the experiments are so long-lived?

(Mr Martin) That is certainly the case, particularly as you move increasingly towards colliders where there are only a number of experiments which you can do on them. Again, those involved in those experiments would say that they had come up from the bottom, as it were, and you still have competition between the performing groups, rather than being determined centrally and then imposed downwards on the research community. I do not think too much should be made of the difference in that case.

[Lord Dainton *Contd*]

(Mr Guy) Can I offer some lessons from the experience of collaborative R&D programmes of the type of Alvey, where we found generally that projects which were researcher-driven—where researchers suggested the projects, got on with the projects, and were left alone sometimes by senior management and the directorate to get on with the projects—produced excellent technical results. We found that the projects which were put together right from the top by the directorate were often unhappy marriages which rarely achieved very good technical outputs. We found though that the projects which really went somewhere in terms of moving from research to development and into production feel into neither of those two categories. They were the ones generally formulated by the business divisions in companies in conjunction with researchers. The researchers did not do what they wanted to do entirely, they did not do exactly what the directorate wanted them to do but they did what the business units wanted them to do. Those were the ones which were successful in terms of reaching the developmental and production stages.

Lord Dainton] Doing it rapidly and efficiently.

Chairman

557. I am sure you are aware of the Cabinet Office guidelines which have been issued. How easy do you think it is to judge whether those guidelines can be met, in particular as to whether it is cost effective from the national point of view to engage in co-operation, or whether it might not be better to stick to a national programme or a bilateral one. Do you think that it is possible to come to a sensible judgement on this, and that on the whole the right decisions are taken?

(Mr Guy) I think we would argue strongly against the sole use of cost effectiveness as a measure of whether one should participate in international or national programmes, on two main grounds: one, most of the outputs of these programmes are tacit in nature and very hard to quantify and, therefore, it is very hard to get any effectiveness statement at the end of the day; two, we would say that between national and international you cannot really regard them as separate entities. It is not an 'either or' decision. They are usually related to each other in some way. If they run in parallel there is sometimes a symbiotic relationship; sometimes, unfortunately, an overlapping duplication. Other times, when they run sequentially, national programmes act as a valid entry ticket into the international ones. It is not a case of looking at which is most cost effective, they have to be considered in conjunction and with a lot of other criteria in there other than just cost effectiveness.

558. Who do you think should take the decision as to whether or not we should join an international collaboration?

(Mr Guy) That would very much depend on the type of international collaboration that one is concerned with. I can talk on the technology end and Ben can come in on the science end. If you are talking about a pre-competitive R&D programme in something like information technology it has to be arrived at via a consensus, looking at the participants, scientists, industrialists and the various departmental officials involved at national and international Community levels. It has to be an iterative process involving as many of the participants as possible to try and sort out the various aims. Without that consensus, at the end of the day these programmes tend to wander off in all directions rather than go in the ways that the participants would like them to go.

559. In your view where it is within a single research council, say, SERC, do you feel the right decisions are made there, leaving aside the ones that have to go up above the research council itself?

(Mr Guy) I think we have actually started making some progress over the last ten years or so in, for example, the SERC-DTI joint information technology advisory board committee structure. That is a distinct improvement and allows the research councils and the DTI to get together and make decisions jointly. That did not exist in the early 80s. We have seen that improvement. I feel sure that we are going to have to see other arrangements like that in other technical areas.

(Mr Martin) Perhaps I can come to the science end of the spectrum and in particular draw upon the results of some work done in the States on the factors affecting international scientific collaboration there. They have looked at the factors and in addition they have identified different types of policy questions which have to be addressed. This comes back to what my colleagues were saying about cost effectiveness being too narrow and too limited. They say that there are essentially four different types of issue which you have to think about. First of all, there is a choice of area that you are going to engage in in international collaboration, and that will depend on your own national strengths or weaknesses, other countries national strengths and weaknesses and what other countries' priorities are. Secondly, there is the choice of partners. Here some of the criteria are: are the partners at a similar sort of level of scientific development? Because if there is an imbalance between the two, after a while this will probably give rise to some sense of dissatisfaction because the flows of benefits are mainly in one direction. Other factors are: are these partners going to be reliable? I am afraid in some European countries you will find the criticism that Britain has not been a very reliable partner in some instances. The third thing is the type of organisational mechanism. We were discussing this earlier. Should it be a big multi-national one or should it be a bi-national one? Lastly, there is the choice of funding arrangement. There is a much wider range of questions and criteria that have to be taken into account.

[Chairman *Contd*]

560. Can we turn now to the European framework programme. We have heard several complaints that the Treasury's attribution system leads to the problem, in some cases, of under-estimating inflation and problems of foreign exchange, but also generally as programmes develop that there have been serious cases of it affecting the resources available for domestic programmes.

Have you found evidence of this, or is it what people should fear in the future rather more than what has happened already?

(Mr Martin) It has certainly caused problems in the past, I know, in relation to the subscriptions of CERN and the other big subscriptions SERC has to pay. Again in other countries they say "This is silly, why should unforeseeable fluctuations in exchange rates mean there is less money left at SERC for national programmes?" Maybe a mistake was made in the past when SERC benefitted from these fluctuations and pocketed the money and afterwards the Treasury decided they could not have their cake and eat it and in future they should bear the losses as well as the benefits. If that was the origin, it was a mistake, and the sooner it is rectified the better, because it does give rise to this problem of national programmes suffering more than international programmes, and that should not happen. You should have the mechanism to avoid that happening.

Lord Nelson of Stafford

561. How would you see that being changed? Or how would you like to see it changed?

(Mr Martin) The only option is to take the international subscriptions out of individual research council budgets, as they do in France, where it is paid by the Ministry of Research and in Germany by BMFT rather than by the CNRS in France or Deutsche Forschungsgemeinschaftin Germany.

562. We have no mechanism for doing that because we have no ministry.

(Mrs Sharp) It could go on to the DTI budget or the DES budget.

(Mr Martin) I think in France it is the Ministry of Foreign Affairs which actually pays it.

(Mrs Sharp) I think it is too.

(Mr Martin) So it could come to the Foreign Office.

Chairman

563. Surely that would not make any difference, trading it, because you still have to make provision for it. It is not going to come off teachers' pay!

(Mrs Sharp) As long as you do not take account of variations in the exchange rate, it makes no difference at all. Somebody has to take the cut somewhere. The question is whether the cut is taken by the other researchers, out of their budget grants, which is happening at the moment. When the exchange rate provision of the CERN budget becomes a bigger item, there is less money elsewhere in SERC. The same would be true more generally of the Foreign Office or the DES.

564. I cannot understand how you spread it across. I can see how you can work something like in the easier days of the Ministry of Defence when you were allowed price increases—you have your budget and if there were pay and price increases during the year you were able to say, "I need more money to cover these."

(Mr Martin) The problem is the short term fluctuations. At the start of the financial year some fairly rational decision is made about the balance between national and international efforts which people are willing to accept, but then the problem comes a few months later when some exchange rate alteration means suddenly there is less money left for national programmes. If people had known that in advance, they would not have struck the same balance between the two. So, yes, every year—or, ideally, one should move more to a multi year budgeting system—but at periodic intervals you have to put the two together and ask the question, is this a proper balance between the two. But between that period of looking at it and the next one, if there are these currency fluctuations, the national effort should not be expected to pick up the difference.

Lord Flowers

565. There are really only two relatively minor issues which push you in the direction of the Foreign Office. One is the exchange rate fall, which is a very technical matter and if the Treasury invented a sensible rule we might get around that, except they do not want to. The other is the undoubted fact there is some Foreign Office consideration in British scientists joining an international project. It is hardly a large issue for the Foreign Office but it is an important issue, and set up the way we are, it is not easy to get that foreign policy element into British science, but it is not in CERN and the Foreign Office plays a full part in determining the British attitude to CERN. I would be very interested in your comments on this. It does seem to me the argument for putting the responsibility for international science on the Foreign Office, as they do in France, has been a good one.

(Mr Martin) To take the example of France again, I think I am right in saying even though it is administered by the Ministry of Foreign Affairs it still bears on the civil research budget for which the Ministry of Research and Technology is responsible; money which then goes to the different departments with research responsibilities. So at a certain point in the decision-making process, presumably every year or so, there is some attempt to make these judgments between national and international efforts, even though it is then administered by the Ministry of Foreign Affairs.

Lord Dainton

566. Even if there were no fluctuations of exchange rates, the principle of attributions in this country does create a problem, does it not, because that places an envelope around a field of activity, whether it is engaged in overseas or at home? How do you react to that particular problem which can have in principle quite a large disbenefit, particularly on small contracts which would be affected by a reduction at research councils of money in particular areas?

(Mrs Sharp) I think that, as you rightly suggest on this issue, somebody's budget really has to bear the cost of it, and it is in the end slightly arbitrary as to who bears it.

567. But the effect is to provide a disincentive for British scientists to be successful in international competition or international activities?

(Mr Martin) Yes, we would agree with that entirely, and again European researchers who we talk to say, "This is crazy, that the British scientists", who they admit are amongst the best in that particular area, "are being penalised for their success". And they think this is crazy particularly given a Government philosophy that those who are stronger should in some way or other get the benefits. They clearly are not benefitting in this particular case.

568. Have you any suggestions as to how this position might be rectified?

(Mr Martin) The implication of what I have just said is that I do not think the notion of attribution should apply, certainly in the case of more basic areas of research. There may be more argument for the more applied areas but for basic research I do not think this is the right way forward.

569. If one was a young scientist being penalised in this country, the obvious thing is to go to Europe?

(Mr Martin) Yes, and that then opens up interesting questions as to what will happen after 1992.

570. That is the question I was coming to.

(Mr Martin) Okay. There seems to be an assumption running through some of the questions we were given that international scientific collaboration in many cases implied European collaboration as organised through the EEC. I would see that as not necessarily a particularly desirable way to go. It would involve too much concentration of resources which in turn might lead to more bureaucracy, slow decisions and so on. One option which could be explored perhaps internationally, on an experimental basis, is to have British research councils open their doors to scientists from one or two countries initially—maybe the Netherlands, Germany, whatever—if they in return opened their research councils to British scientists for their proposals. That would then provide a means for these British scientists, who for one reason or another fail to get money in Britain, to go and try elsewhere. If they are as good as they say they are, they should do well from such a system. In addition, I would have thought it was a mechanism which suited this Government's philosophy about the free market rather than centralised bureaucracy in Brussels. I do not think it should be done dramatically over night but on a small scale as an experiment and, if it works, then gradually extend it from that to bring in other European countries.

Chairman

571. Arising out of that, would you like to comment on whether the European Framework Programme and the fact we are so committed to that in many ways, although it is a limited field, has any serious effect on collaboration elsewhere, particularly the United States or Japan?

(Mr Martin) At that point I would bring up some other work which has been done recently, looking at the pattern of international collaboration, again in the more basic areas of science. This shows international collaboration has been growing quite rapidly over the last 10 or 15 years so that something like 15 per cent of scientific papers involve international collaboration.

During that time obviously you have had the European Commission assuming an increasing role —it perhaps has doubled over that timescale. Collaboration between one European country and another has grown no faster than that between one European country and a non-European country, often the United States although now perhaps the East European countries are coming in. That goes back to the point made by my colleague, Margaret Sharp, earlier that Government policies cannot force collaboration to emerge from nothing; all it can do is build upon existing links. Another part of that work I referred to involves analysing and mapping out patterns of international linkds—that is, it is drawn on maps, as it were, and if two countries work a lot together they are very close together on the map and if they do not they are further apart on the map. The astonishing thing about this is that the maps look particularly like geographic maps—in other words, it is historical and cultural factors which are most important in shaping international links rather than where are the best scientists around the world to collaborate with. The European Commission cannot force international collaboration to happen —all they are able to do is build on existing links.

Lord Dainton] In the third Framework Programme, if I have understood it correctly, I understand one of the objectives of that programme would be to promote social cohesiveness and to do this they are proposing establishing, I think it is 5,000 or some such, large number of fellowships which will be available throughout Europe. Do you regard that as a wise means of ensuring good scientific work and co-operation? What does it mean?

[Chairman *Contd*]

Chairman] I think the second question should have come first.

Lord Dainton

572. Am I correct in this?

(Mrs Sharp) No. What is known as Stimulation part of the Framework Programme, this is in fact a minor part of it. I think part of the idea lying under this notion of social cohesiveness is actually, if you like, European cohesiveness. You ask: "is it a good idea?", I think it is a thoroughly good idea. At Sussex we run a programme which is called the Science and Europe Programme and we have been doing it now for about 12 years. It started with a few students who took in addition to their ordinary three-year science course, an extra year to learn the language and spending time in France, Germany or Italy. This has now grown to about 70 students who spend their third year studying physics, chemistry or biology at a university in that country. When they come back, they are European as well as being Britons. They think "European" in a way they did not before they went. They are part of a new generation of young people whose horizons are very much broader than our's at an equivalent age used to be. I think it is of vital importance that these programmes engage international exchange, both at the student level and perhaps particularly at post-graduate and post-doctorate levels. This is an important part of the European effort in basic science. I would be sad to see the Commission taking over much more of what are at the moment national science programmes. I think the appropriate level for the distribution of research grants for basic science is probably the national level, rather than the European level. There are great dangers of too much concentration. I support the premise that pluralism in basic science is a good thing.

573. I accept everything you say about the under-graduate levels but with the post-graduate levels I am worried that the criterion of choice and selection might introduce an element which is not of that good a science quality, either on the individual or the level proposed. Do you think there is a danger of that?

(Mrs Sharp) I do not know enough about this particular programme or what they are proposing to do, or what the objectives are. Certainly in relation to programmes I have seen in the biotechnology area, all the proposals that come forward are peer reviewed. Provided you have mechanisms of this sort, for making sure that good science is being pursued, then that is fine. I do not know whether this applies to this particular bit of the Framework Programme.

Lord Lewis of Newnham

574. I was just wondering, in relation to the other exciting programme which you have been mounting in Sussex, actually how far do people stay in this country having gone through these programmes, or how far do they go back to the country in which they took their third year course? Is there any increase in the translation of people from the UK to these countries? I find this interesting because sometimes one argues the real barrier for people going to Europe is the language barrier but I think you have surmounted that barrier.

(Mrs Sharp) I think we have surmounted that barrier. I would like to see this programme extended to many other areas of study. But there are other barriers. Let me give you an example: at the moment two students have come back and completed their degrees last year. They were over at Freiburg University and they want to go back and do their PhDs. The problem that arises at the moment is Freiburg will not accept the four year degree at Sussex as being equivalent to the Doktorarbeit which is required—rightly, because the doktorarbeit is a broader based programme. This is an issue which has to be sorted out in Europe given the Erasmus programmes. It illuastrates the sort of problem that those who are currently administering the science in the European programme are trying to grapple with.

Chairman] On that upbeat note, thank you very much for the evidence which you and your colleagues have given, it has been most helpful. Thank you.

Memorandum by Professor Sir Robert Wilson, CBE, FRS

The Department of Physics and Astronomy at University College London is conducting research programmes in several areas of physics and astronomy which it believes lie at the forefront of the subjects. This claim is supported by the assignment of the highest rating to the Department in the UFC research assessment exercise of 1989. The programmes are also heavily internationalised with the nature and degree of international collaboration varying widely. These include institutionalised European agencies such as Centre Europeen de la Recherche Nucleaire (CERN) and the European Space Agency (ESA), international collaborations such as the Anglo-Australian Observatory (AAO), the La Palma Observatory (LPO) and the James Clerk Maxwell Telescope (JCMT), *ad hoc* international projects such as the International Ultraviolet Explorer (IUE) and the Röntgen Satellite (ROSAT), access to facilities provided by other countries (German particle collider, HERA, US, Soviet and Japanese satellites), and research funded by the Stimulation-Action Programme of the European Community. It seemed clear, therefore, that a submission by the Department to the Sub-Committee of the House of Lords Select Committee on Scientific Programmes could be of value. This document presents the observations and comments of groups in five different areas, as follows:

- Elementary Particle Physics (Professor F W Bullock and Dr D J Miller).
- Ground-Based Astronomy (Dr A J Willis).
- Space Science (Professor J L Culhane, FRS).
- Atmospheric Physics (Dr D Rees).
- Positron Physics (Dr M Charlton).

The views expressed are those of each group as presented by the authors.

This Summary will be restricted to those comments and recommendations which are both major and common to the different groups. They will be listed under the headings as given in the letter of Mr R H Walters of June 1990.

(i) Advantages and Disadvantages of Joining ISPs

In the areas of research conducted by this Department (and, we believe, by the UK in general), it is essential to join ISPs in order to remain at the forefront of the subject because national resources are insufficient on their own. It should be added that such interactions probably have benefits, possibly not originally envisaged by the scientist, which lie beyond science. We therefore believe that the advantages of joining ISPs are overwhelming.

One disadvantage of major, multi-national ISPs seems to be a tendency to be less cost effective than national counterparts. Clearly, some increased cost must be incurred as the price of running a multi-national organisation, but separate reviews of CERN (Abragam) and the Science Programme of ESA (Pinkau) both concluded that significant cost savings could be made. The extent to which these are implemented will be a matter of interest for the future

Other disadvantages of joining ISPs seem to stem mainly from the difficulties posed by the need to adjust national policies, resources and procedures so as to maximise the whole endeavour and the national returns from it. It is striking how different is the approach of different countries to this problem, particularly in respect of the institutionalised European agencies, CERN and ESA. Here, the main continental countries support a relatively much larger national programme than does the UK, on the grounds that this is the best way of exploiting and influencing the facility. The evidence indicates that they are right. The situation is exacerbated by the UK method of funding the programme (again, quite different from our partners) which is dealt with under (viii).

(ii) Advantages and Disadvantages of Hosting Large Facilities

We believe that there are major advantages to the host country in housing a large ISP. The advanced technology involved stimulates local industry, the science excites public interest and the presence of the facility can become a matter of national pride. Also, there is an economic benefit from the purchasing power of the staff employed and the visiting scientists.

The poor performance of the UK in winning the location of international science establishments that is subscribes to should be a matter of concern.

(viii) Impediments within the UK to Engaging in ISPs

One general comment can be made from the experience of involvement in a wide range of intenational collaborations—to have a successful ISP, it is essential for the participating countries to adopt a flexible approach and to be willing to modify national procedures for the benefit of the whole. There are some areas, addressed here, where it can be questioned whether the UK has been sufficiently flexible.

National subscriptions to the large ISPs, CERN and ESA are calculated by a formula depending on GNP and expressed in a particular currency. This means that the fluctuations in GNP and in exchange rates induce fluctuations in the subscriptions. The UK procedure for handling this is to leave the problem entirely with the funding body, in this case the SERC. Unfortunately, the SERC budget is not large enough to cope with these perturbations without severe disruption to the rest of its programme. Since it would be inequitable to impose the fluctuations on areas outside those concerned—particle physics and space science—it is not surprising that they have to carry the main burden. The result is that an increase in subscription results in a decrease in the corresponding national budget or, in other words, an increase in the UK contribution to the international facility results in a decrease in its ability to exploit that facility. This worsens the problem referred to in (i) above whereby the UK supports a national programme at a level relatively well below those of our main partners. Pushed to the limit, these policies will reduce the returns to the UK to the extent that it will be subsidising the science of others.

In other European countries, the subscriptions to CERN and ESA are not coupled to the basic science budget, but carried by a major department of state large enough to accommodate the fluctuations without damaging repercussions. We believe that the adoption of this policy by the UK would be beneficial to its science programme and also demonstrate its flexibility of approach to ISPs.

Other problems stem from the fact that UK salaries are significantly less than their continental counterparts. At the present time the consequences cannot be described as serious and are being contained, but there is a long-term danger, with the impending growth of EC funding and European institutions, that a net flow of UK scientists and engineers to the continent will result.

Elementary particle physics

Introduction

The group has extensive experience over more than 30 years of working in International Scientific Programmes. Group members have collaborated in programmes at Berkeley, Brookhaven, Fermilab and Michigan in the USA, as well as maintaining a continuing programme at CERN (Geneva) and, more recently, at DESY (Hamburg).

The following notes represent the collective experience of those currently participating in and, in some cases leading, University-based research teams working at the SPS Accelerator and the LEP Collider at CERN and the HERA Collider at DESY.

(i) Advantages and Disadvantages of Joining ISPs

The advantage of belonging to an International Organisation like CERN is very clear. The UK could not afford to participate in this aspect of frontier science without large scale International collaboration to provide the facilities, instrumentation and expertise to which access is essential if progress is to be made. British Universities have an excellent record of bringing data home for analysis and of developing new ideas in their own laboratories. The same advantages apply to the programme at DESY which, however, is a national laboratory to which the UK does not subscribe funds. Nevertheless, full participation in programmes at this laboratory requires the UK to provide its full share of funding for the instrumentation it uses.

Undergraduate and postgraduate students benefit because they feel they or their teachers are in direct touch with the frontiers of human knowledge—an important part of their motivation. University teaching also benefits because the staff are familiar with the latest instrumental, experimental and computing technology which can then be presented in lectures and incorporated in projects. This is a real, if seldom recognised, route for technology transfer from fundamental research fields via new graduates into industry and commerce.

UK industry can benefit (although it has been extremely reluctant to do so) through tendering for contracts on the advice of UK national institutions or simply by word of mouth recommendation from participating UK physicists. It can also benefit by virtue of the fact that UK scientists and technicians working in an international organisation become embedded in an environment where foreign industry is the main supplier. They see the products on offer and the style of marketing used and will transfer this knowledge when they return to the UK academic or industrial sector.

Workers with school age children who spend time at an international organisation have the very significant benefit of a direct comparison of educational standards and methods in the host country with those in the UK. This, regretably, is not always to the advantage of the present UK educational system, but may be some small help in influencing future developments.

The main disadvantage is the necessity for some of the members of a research team to spend long coherent periods abroad. This is almost impossible for members of the permanent academic staff who must, in general, carry a full load of teaching. To make a full contribution to an international programme it is absolutely essential that the funding body provides dedicated staff (Research Fellows, etc.) who can maintain a presence at the site of the experiment. This necessity has been traditionally recognised by the SERC (the principal funding authority for Elementary Particle Physics) but the level of provision in this respect is now often too low for the UK to take leading positions in international programmes.

(ii) Advantages and Disadvantages of Hosting Large Facilities

The advantage of hosting large facilities are also fairly clear as can be seen from the experience of CERN. The regions of Switzerland and France around Geneva are developing a wide range of science-based industry, an important component of the great prosperity of the region and a direct result of the presence of CERN. Qualified electronic technicians and engineers commute up to 50 kilometres a day to work at the laboratory. There is a pool of well qualified contract technicians, who have moved to the district from all over Europe, available to CERN or to other local employers. Any high-technology ISP based in the UK would have a similar stimulating effect on the local region.

The presence of a large facility in the UK would bring an immediate and accessible benefit to schools and Universities which would feel closer to the forefront action. Also the awareness of the general public to scientific research would be considerably heightened. This can be seen very markedly in Geneva where visits to CERN are popular and frequent, and the general public has considerable pride in being host to a world-leading scientific laboratory.

(iii) The Setting up of International Programmes

From the point of view of Elementary Particle Physics, the machinery for instituting international programmes is well established and works well. Within the SERC there is a definite problem when a proposed ISP does not fall clearly within the boundaries of the pre-defined funding areas (e.g., Nuclear Physics Board, Science Board, etc). This has been an unsatisfactory aspect of the SERC for a very long time, and remains a problem in spite of much criticism. A recent example is the difficulty over funding the Sudbury Neutrino Observatory, in which project the UK could have taken a leading role. Internal dispute over whether it was an Elementary Particle Physics programme or an Astronomy programme eventually produced no more than "poor relation" status for the UK.

(iv) Technical and Financial Criteria for the Consideration of Proposals for ISPs

The present peer review mechanism, evolved over many years, works surprisingly well in the field of Elementary Particle Physics.

(v) The Forums in which the Decision to Participate in ISPs is Normally Reached

For Elementary Particle Physics, the only forums in which decisions are reached are the peer review committees. Each and every proposal is given full and fair consideration unless (iii) above is the case. The only criticism that might be made is that the peer reviewing process is too detailed with committees spending too much time on minutiae and too little on broad (and long-term) strategy.

(vi) and (vii) No comment.

(viii) Impediments within the UK to Engaging in ISPs

The CERN subscription is fixed by formula and is a first charge on the SERC budget for Nuclear Physics. This can generate serious strains whenever the pound weakens against the Swiss Franc. A small (few per cent) fluctuation in the subscription can produce a massive (perhaps 20 per cent) fluctuation in the amount left available to University laboratories. international subscriptions of this sort which depend so absolutely on the vaguaries of international finance should be funded directly from the Treasury (who negotiated the method of subscribing in the first place). This would be in line with the practice in most other member states.

Travel and support funding for the participating groups comes from the remainder of the Nuclear Physics Board budget after funding the CERN subscription. This has been cut disproportionately over the last few years, leading to a situation in which groups from other countries, including non-member states, can spend more time in Geneva and participate more fully in the analysis and publication of results than can University-based UK researchers who have made an equal contribution to the construction of the experiments. Shortage of support funds may also make it difficult for UK groups to play their customary role in the conception and development of the accelerators and detectors for the next round of experiments.

The cost of living in Geneva (and in Hamburg) is high by UK standards. UK scientists on visits to CERN or DESY are supported at a reasonable, but by no means over-generous, level. Because UK salaries are significantly lower than many of our international collaborators, the marginal cost of keeping staff abroad rather than at home is somewhat higher for us. High travel and subsistence bills cannot be avoided if we are to benefit fully from our membership of ISPs.

(ix) Impediments in Other Countries to Their Engaging in ISPs

Eastern bloc scientists have found ingenious ways of collaborating in ISPs in spite of the manifest difficulties. The UCL group has collaborated with Polish groups for more than two decades on various experiments using the nuclear emulsion technique with great success in spite of the fact that little or no financial support has been available to the Poles. The current "Westernisation" of the East will surely ease the way to international collaboration, something which will be unanimously welcomed by Elementary Particle Physicists in all ISPs.

GROUND-BASED ASTRONOMY

Introduction

UK ground-based optical, infra-red and milli-metre astronomy is primarily conducted at major observatories overseas which in many cases were constructed by the UK, but now mostly involve joint-funding through international collaboration. These are: the optical observatory on La Palma, Canary Islands (UK-Spain-Netherlands), the Anglo-Australian Observatory (AAO) at Epping, NSW (UK-Australia), the Infra-red Telescope (UKIRT) on Hawaii (UK), and the James Clerk Maxwell (JCMT) mm-wave telescope on Hawaii (UK-Netherlands-Canada). UK funding for participation in these observatories is determined annually through SERC and its Astronomy and Planetary Sciences Board. In addition to these overseas observatories there are two UK-based SERC establishments, the Royal Observatory Edinburgh (ROE) and the Royal Greenwich Observatory (RGO, now at Cambridge) which are respectively responsible for managing the Hawaian and La Palma operations. In contrast the AAO is managed by a joint SERC-Australian AAT Board, and is fully operated by a team at the observatory site.

The Department of Physics and Astronomy at UCL is a major user of all the above overseas telescopes and has also designed and constructed major instruments for general use at each observatory. The Department has additionally provided the Chairman of the AAT Board and the JCMT Board, as well as membership of the different observatory's SERC Steering and User Committees, SERC Council, the APS Board and its sub-committees.

(i) Advantages and Disadvantages of Joining ISPs

The internationalisation of the UK's ground-based observatories on Hawaii, La Palma and in Australia, has provided a much-needed financial contribution for their continued operation and enhancement over the past decade or so during a decline in SERC funding for Astronomy (Note: the UK had to withdraw from its partnership with South Africa in the SAAO due to funding cutbacks). In addition, our international partners have assisted in instrumentation provision for these facilities. In the case of the Hawaii and LPO observatories, the addition of new funding partners has been accompanied by a pro-rata reduction in the amount of observing time available to UK-based astronomers (the AAT from its inception involved a 50:50 share in funding and time allocation between the UK and Australia).

Access to these major ground-based facilites keeps the UK at the forefront of this field and also provides excellent training for university research students in operating state-of-the-art equipment. Additionally, UK universities have had the capability of developing novel instrumentation for these telescopes, providing excellent postgraduate training in optical, electronic mechanical engineering and computer skills. At UCL this R&D has further led to the development and construction, in-house, of major instruments for general use at each observatory, including: the IPCS detector for the INT and WHT telescopes on La Palma, an infra-red spectrometer (CGS3) for UKIRT, and an echelle spectrograph for the AAT.

(ii) Advantages and Disadvantages of Hosting Large Facilities

While our main telescopes are physically located on excellent sites overseas, the UK does retain two, home-based SERC establishments—the Royal Greenwich Observatory (now at Cambridge) and the Royal Observatory Edinburgh, responsible for running the La Palma and Hawaii observatories respectively. RGO and ROE provide support astronomers and technical staff on the island sites and in addition, retain substantial teams in the UK for the provision of instrumentation for the overseas facilities. These arrangement are in place largely for historical reasons, and it is questionable whether they provide the most cost-effective method of operational support.

By contrast the AAO is run in a very different manner, in that all staff associated with the observatory are located on a site close to the facility in Australia (*viz* there is no UK-based establishment associated with it). There is no large instrumentation team at the AAO, rather its new instruments have generally been procured by the AAT Board from the most suitable source, often a university group. The AAT is generally regarded as one of the best equipped optical telescopes in the world. We believe that a move towards operating and managing the observatories on Hawaii and La Palma in the AAO-model would provide significant benefits to the UK, both in terms of cost savings, and in stimulating instrumentation technology in the Universities.

(iii) The Setting up of International Programmes

International programmes in ground-based astronomy are generally set up by inter-agency discussions and negotiation between SERC/APSB and its counterparts overseas. Proposals for major new facilities may be initiated from individual scientists and the astronomical communities, but detailed discussions usually quickly involve SERC and one or more of its home-based establishments. An example here has been the recent proposals for the construction of new 8-m class optical-1R telescopes via international partnership either with Spain (on La Palma) or with the US and Canada on Hawaii/Chile. The UK can afford to be involved in only one of these projects, and the past year or so has seen intensive discussions as to which option to go for. Unfortunately this debate has become partially polarised by the fact that one SERC establishment (RGO) would be heavily involved in one option (the Spanish) and the other SERC establishment (ROE) would be heavily involved in the other (US-Canadian). We believe that scientific, technical and cost-factor considerations should have complete priority in reaching the final decision.

(iv) Technical and Financial Criteria for the Consideration of Proposals for ISPs and

(v) The Forums in which the Decision to Participate in ISPs is Normally Reached

Proposals for major, new capital projects are normally subjected to intensive Phase A studies to determine feasibility, technical readiness and costs. This is usually carried out by a team appointed by the APSB including international representatives when relevant. In general, the UK cost of participation in new ISPs have to lie within the envelope of the Forward Look of the APSB and its long-range planning. The chain of peer review within SERC is extensive and generally consists of (i) consideration by a scientific and technology Assessment Panel, (ii) the Ground-Based Programme Committee of the APSB, (iii) the APSB itself (which usually has to provide all the necessary funding), and SERC Council which gives the final approval within its delegated financial authority. This procedure can take two to four years (sometimes longer), and does not always match the approval timescales and mechanisms of potential overseas partners.

(vi) Government Practice and Guidelines on ISPs

Government practice on ISPs is handled through SERC, its officers and the APSB and its committees. In general the mechanisms and guidelines are well practised and understood throughout this peer review structure. Whilst Treasury rules regarding underindexation and currency fluctuations are understood, they are not considered beneficial to the UK astronomy programme.

(vii) Treasury Rules of Additionality and Attribution and

(viii) Impediments Within the UK to Engaging in ISPs

The main problems associated with the above are financial, in respect of currency fluctuations associated with UK costs of maintaining telescopes on overseas sites. In addition, current Government practice with regard to compensation for inflation has for many years involved significant underindexation which has a major adverse effect on the APSB programme which is so heavily weighted to international programmes and support of its SERC establishments.

The costs associated with currency fluctuations and underindexation must be accommodated within existing SERC/APSB funds, with little or no ability to carry forward from one year to the next in accordance with Treasury rules. In most years, currency fluctuations have an adverse effect, and with International Programmes usually protected in the Forward Looks of SERC and Boards, the funds available for the domestic programme and exploitation of the overseas facilities are reduced.

SPACE SCIENCE

Introduction

Starting with the US/UK Ariel I satellite, the first ever international collaborative project in Space Science which was launched in 1962, UCL groups have a long and distinguished record in the international arena. Particularly noteworthy successes were achieved with the US/UK X-ray Astronomy mission Ariel V (launched in 1974) which established the UK groups as world leaders in the field, with the US/UK/ESA International Ultra-violet Explorer (IUE, launched in 1978) which is one of the most successful space Astronomy missions ever flown and which continues in operation twelve years later and with the ESA Giotto mission to encounter Halley's Comet in 1985 which had on-board the very successful Plasma Analyser provided by the College's Mullard Space Science Laboratory (MSSL).

At pressent UCL research groups are analysing data from or providing instruments for more than 20 space missions. These cover a large number of Space Science activities including Atmospheric Physics, Earth Remote Sensing, Solar Physics, Space Astronomy (including IR, visible, UV and X-ray), and Space Plasma

Physics. In addition specialist teams skilled in Electronic and Mechanical Engineering for space applications have been established at the MSSL. These teams play a vital role in the design and development of space instrumentation to the highest engineering standards. They also underpin an increasing involvement in several applied space science and engineering topics including the study of spacecraft charging in orbit, the development of spacecraft attitude sensors and the application of space radar data to resource mapping.

Except for Earth Remote Sensing, all of this work is mainly supported by the UK Science and Engineering Research Council and is undertaken with a wide range of international collaborators. Facilities for the work —the spacecraft and their launchers—are provided by the European Space Agency (ESA) of which the UK is a member. Access to space is also achieved through bilateral or multilateral arrangements with other nations. Collaboration with the US National Aeronautics and Space Administration (NASA) has been underway from the beginning and has been extraordinarily cost-effective. More recently UCL groups have gained opportunities in the space programmes of Japan and the USSR. Thus after more than three decades of involvement in space science and engineering, UCL researchers have established a considerable base of experience in the field and have collaborated widely with a variety of international agencies and partners throughout the world.

(i) Advantages and Disadvantages of Joining ISPs

In the space area the high cost of spacecraft and of their launch vehicles in particular means that international collaboration is virtually mandatory if UK research groups are to play a leading role in the many important areas of science that require access to space. While the UK has in the past constructed its own satellites and while it is possible in principle to purchase launch services, both of these courses are at present beyond the means of the Research Councils. However reductions in launcher costs might permit these activities in future for small payloads.

Since the first UK space mission—the joint US/UK Ariel I launched in 1962—a dual pattern of collaborative activities has evolved. Payment of a GNP related subscription to ESA entitles UK participation in the ESA "mandatory" science programme. Although the programme is broadly based, the rate at which opportunities arise is inadequate to sustain the health of UK space science. In addition the important field of Earth Remote Sensing is not included in the mandatory science programme. Therefore the UK, in common with other ESA members, also collaborates on a bilateral basis with nations such as the USA, Japan and the USSR. While these interactions are extremely cost effective and permit the gaps in the ESA related programme to be filled, they arise on an essentially opportunistic basis. Thus both modes of working are essential if a balanced programme is to be maintained across the entire range of UK interests. This is especially true for studies of Climate and Global Change from space which have recently attained considerable importance.

It is vital that the UK have a strong domestic programme if we are to take advantage of the opportunities offered by participation in ESA on the one hand and by bilateral collaborations on the other. The ratio of our national to our ESA related spend is the smallest in Europe and needs to be increased if we are to benefit appropriately from our subscription to the ESA mandatory science programme.

(ii) Advantages and Disadvantages of Hosting Large Facilities

The establishment of large facilities related to ISPs in the UK would bring considerable benefits. Related, usually high technology, industries could be established. UK universities and schools would gain from the possibility of more detailed exposure to the activities and achievements of the facility and its international staff. Finally the public awareness of Space Science would be considerably heightened. Given that no exceptional recurrent expenditures are required of the host nation beyond its normal subscription to the ISP, it is difficult to think of any corresponding disadvantage.

However it is most regrettable that a situation has arisen from the start in which no major ESA (previously European Space Research Organization or ESRO) facilities were established in the UK. Such facilities exist in France, Germany, Holland and Italy but in the UK only a small contract research activity in Space Tribology is operated for ESA by the UKAEA. In addition to the reasons given above, this is also unfortunate because the existence of major facilities confers the advantage of a closer association between the Agency and the host country. This can permit the latter to exercise a greater influence on the activities of the former. While it is unlikely that the ESA mandatory science programme will require the establishment of any new facilities in the near future in the UK or elsewhere, facilities such as the UK Earth Observation Data Centre at Farnborough will play a role in the optional Earth Resources programme through the analysis of data from the ERS-1 and -2 satellites. In the future as this programme expands, it may be possible to bid for the establishment of related facilities in the UK. The growing interest of the EEC in the use of space-based techniques for environmental monitoring and control may also lead to the establishment of European facilities. Given our previous failures to secure any ESA facilities, it is of the utmost importance that the UK be prepared to take the necessary political action at the highest level to secure any opportunities that may arise in this area in future.

(iii) The Setting up of International Programmes

Prior to the establishment of the British National Space Centre (BNSC) the various UK Government Departments involved in space interacted separately with ESA and other space agencies and national programmes. The co-ordination of all of these activities is now in the hands of the BNSC and the situation has been considerably improved particularly for interactions with ESA. It is therefore important that the involved UK Departments (DES including the Research Councils, DOE, DTI and MOD) should continue to co-ordinate their space work and strengthen the role of BNSC in implementing the overall UK space programme.

The influence of the UK both in ESA and in the space agencies of other nations depends primarily on the health of the national programme. ESA offers the facilities (launchers and satellites) for access to space but the selection of particular scientific investigations is highly competitive and the underlying technical and scientific developments that are required for success must be supported at the national level. This is also true for bilateral programmes where UK participation can only be achieved on the basis of the potential benefit to the collaborating partner and of the technical excellence of the proposed UK role. Our reputation as a reliable and successful partner in past collaborations is also a most important factor. The present situation does not favour our continued success in these areas. At a value of 0.07, the ratio of our spend on national and bilateral space science projects to that on ESA is the lowest in Europe. The figure for France is 1.09 but the figures for Italy and Holland at 0.52 and 0.28 respectively have very worrying implications for our future competitiveness in the field. Those nations with a higher spend on their domestic programmes will increasingly come to dominate ESA and our subscription will become a subsidy for access by others rather than a means of enabling our own research programmes.

(iv) Technical and Financial Criteria for the Consideration of Proposals for ISPs

Here the peer review mechanisms by which the scientific, financial and technical aspects of particular scientific investigations to be carried out within the ESA programme are evaluated are in general quite effective. This also applies to the evaluation of UK participation in bilateral co-operations with other nations such as the USA. However a problem arises in the lack of a clear separation between the funding of particular investigations within ESA and the payment of the UK subscription to the ESA mandatory science programme. The latter must at present be found from within the SERC budget for space science. Thus increases in the mandatory subscription either due to new agreements between member states, to variations in exchange rates or even in GNP figures can seriously threaten the support of the national space science programme which in turn supports the actual participation of UK research groups in ESA missions. In other European nations funds for the ESA subscription are considered separately from the requirements of the scientific programmes themselves.

(v) The Forums in which the Decision to Participate in ISPs is Normally Reached

In the area of Space Science UK participation in ESA and in its purely scientific predecessor ESRO was agreed upon in 1964 and has continued up to the present. Since the ESA science programme amounts to about 10 per cent of the Agency's total budget, the interests of the UK and the nature of our national participation are much broader than those of the scientific programme alone. Thus considerations related to UK participation have major political implications and would involve several Government Departments.

A recent report* on the management and efficiency of the ESA Science Programme although largely supporting the operation of the programme itself, commented in unfavourable terms on several aspects of the activities of the Agency in general which have a negative effect on the conduct of Space Science in Europe. In the UK the existence of the BNSC has meant that the conclusions of this review of the Science Programme can be rapidly assessed and used to benefit the larger UK role in ESA. Although a purely scientific programme could probably be run more efficiently, UK interests overall are better served by participation in a single European Space Agency. In this context however it is important that the political dimension of scientific participation in ESA be recognised particularly in respect of the provision of the national subscription to the mandatory science programme.

Decisions relating to participation in bilateral and multilateral scientific programmes are handled by the normal review mechanisms of the Research Councils and, given satisfactory support for the national space science programme, can usually be reached in a satisfactory manner.

* Report of the 1989 Science Programme Review Team (the Pinkau Report) to the Council of the European Space Agency.

(vi) Government Practice and Guidelines on ISPs

The principal comment to be made under this heading has already emerged in several of the preceding replies. The major disadvantage of the present approach to UK participation in the ESA mandatory science programme lies in the need to find both the national subscription to ESA and the support for actual participation in the scientific programme from the same budget heading. Thus the national programme budget should be protected from changes in the UK subscription arising from political factors, exchange rate of GNP changes. This is the case for other ESA member states.

(vii) Treasury Rules of Additionality and Attribution

Neither the ESA science programme nor the work conducted on a bilateral or multilateral basis with individual nations is affected by these rules. In the former case the payment of the national subscription to the mandatory science programme leads to the provision of spacecraft and launchers on which the UK groups can compete for space based only on the quality of their proposals. ESA does not fund the provision of scientific instruments or the exploitation of the data that they acquire. Bilateral or multilateral scientific programmes are invariably undertaken on a "no exchange of funds" basis. Thus there is no inflow of foreign money to the basic Space Science programme.

(viii) Impediments Within the UK to Engaging in ISPs

It again follows from the replies given above that exposure to the effects of currency fluctuations on the level of the annual UK subscription to the ESA mandatory science programme can directly reduce the support available for the provision of scientific instrumentation and the participation of UK research groups in the programme itself. Thus the paradoxical situation can arise in which the UK, having paid its share towards ESA facilities, is unable to make use of them and is in effect subsidising their use by those states who treat their research support separately from their membership subscriptions.

The generally lower level of UK salaries on the one hand makes it difficult for us to attract staff from many of the other ESA member states and on the other makes us vulnerable to the loss of many of our best staff to our continental collaborators and rivals.

Following the recent increase in the number of collaborative programmes with the USSR, COCOM restrictions are causing some difficulty and a relaxation of these rules for instruments which are to be provided by UK groups and launched on USSR spacecraft would be very helpful while in no way violating the original arguments for these restrictions.

For the other examples given (commercial secrecy, intellectual property rights), UK groups have been more than able to hold their own and have competed very successfully on the basis of the excellence and originality of their work.

(ix) Impediments in Other Countries to Their Engaging in ISPs

The concerns raised in the outline of issues under this heading are generally not of great significance. In any case it is up to the UK groups to achieve the most effective collaborations that they can. The outstanding successes achieved since the beginning of the space age, particularly in the area of bilateral programmes, suggest that the UK groups are indeed negotiating effective arrangements for collaboration. The different national budgetary procedure can cause delays in approving and starting research programmes.

Atmospheric Physics

(i) Advantages and Disadvantages in Joining ISPs.

There are overwhelming reasons for joining IPSs if groups, laboratories or institutions are to participate in the planning and execution of front-line research. Such work should thus be rewarding and cost-effective to the UK.

On a pragmatic level, there are very many examples where a very modest financial contribution from the UK, relating to a key science or technology contribution by participating UK group, has greatly augmented an ISP, hosted and mainly funded by other nations; in such cases, the UK contribution may be small but nevertheless buys a very substantial scientific participation, and allows the respective UK community to participate in a major new facility. Particular recent examples occur in the NASA Dynamics Explorer Program, the CRRES satellite, the UARS and Eos Programs.

Except for very small scale efforts, perhaps involving only data analysis of earlier projects, even the collaborative efforts within national and international programmes need very considerable resources within individual institutes. Typically, the successful prior development and demonstration of a key scientific or technical aspect for a project is an essential component of a successful bid to join any International Scientific Programme.

However, the seed-corn resources to enable the prior demonstration of unique techniques require a sustained level of support which is vastly beyond the resources of even major Departments in the larger UK Universities. SERC Grants do not usually provide such seed-corn resources, and current grants cannot be diverted into the essential front-end investment. For major ISPs, it is virtually essential to call on resources of national laboratories and suitably experienced industry to support proposals to join or participate in ISPs.

(ii) Among the many advantages in housing in ISPs is the direct contact of academic and technical staff and students with the broad range of involved people and ongoing activities. This may also generate valuable local public awareness and certainly provides a broad and highly educational experience of all concerned with the wide range of essential day to day activities, and not just the state of the art technology and academic highlights. This is very good experience for students, technicians and managers working in and around the ISP, and not just the academic research workers who are directly involved.

(iii) The Setting up of International Programmes

In the Atmospheric Physics, most ISPs originate with national or international groups initially proposing to ESA, NASA, SERC, NERC. When a rough cost estimate indicates that purely national funds are unlikely to be available to complete the project, a sounding of individuals and institutes on the international scene may result in a proposal for a bilateral or multilateral project. Normally this would be headed by one major international agency, with participation from other national agencies. The type of involvement would depend on the type of project (space, ground-based, modelling) and on national or other agency guidelines. ISPs are normally subject to Peer Review by each agency, with perhaps a special international co-ordinating group to ensure "balance".

(iv) Technical and Financial Criteria for the Consideration of Proposals for ISPs

This is usually by peer review.

(v) The Forums in which the Decision to Participate in ISPs is Normally Reached

Projects, or proposals for new projects are often initiated by agencies (ESA/NASA) circulating a "Dear Colleague" letter, requesting outline proposals. These are judged by peer review and the process seems satisfactory.

(vii) Treasury Rules of Additionality and Attribution

Generally, participation in an ISP will be some combination of an "International Subscription" by the UK (and other countries) agreed on some formal (GNP) or *ad hoc* (vote) basis, and direct funding by the national agencies. There are problems over the carrying forward of committed, but unspent, funds over fiscal years. Minor project delays, or even billing/paying procedures, can create difficulties. Differences between countries and agencies can cause difficulties, such as different rules in the allowance for inflation or separation of main phase funding from follow-on costs.

(viii) Impediments within the UK to Engaging in ISPs

Perceived inequalities of salary or taxation relative to other nationals engaged in the ISP can cause major problems with recruitment/retention of ancillary staff, rather than perhaps academic staff. UK Students have often felt very harshly dealt with regarding travel expenses, etc., relative to other nationals. Inequalities of salaries and travel expenses, or "overseas allowances", between nationals employed by Universities and those with similar qualifications and experience employed by contractors have also caused considerable grievances. Rules such as the abatement of EEC contributions appear somewhat anachronistic. Restrictions on shipment of computer and other hi-tech, equipment have caused problems, and will continue to do so, despite the general easing of E-W tensions. Respecting intellectual property rights should not be a serious problem.

POSITRON PHYSICS

The Department is currently involved in two international collaborations funded by the European Community (EC) under the twinning initiative of its Stimulation-Action Programme. The specific projects are: (i) "Antimatter as Antihydrogen" with the Physics Institute, University of Aarhus, Denmark and (ii) "Collisions of positrons with atomic hydrogen" with the Department of Experimental Physics, St Patrick's College, Maynooth, Ireland.

The Stimulation-Action initiative is different in scope from the type of programme described in the other sections of this document since it functions through a grant-awarding body. Its aim is to stimulate co-operation across national boundaries within the EC and this is achieved by the award, after peer review, of substantial sums of money (typically £100,000) to small groups of scientists working on selected research projects. As far as collaborations are concerned the EC has thus become an important alternative source of funding to the SERC. On a cautionary note, it is not clear what the future role of the EC will be beyond the end of its current science plan in 1992.

(i) Advantages and Disadvantages of Joining ISPs

The EC Stimulation-Action Programme has brought great benefits to the positron group. Foremost, it has facilitated projects which were beyond the resources of the individual institutions. In doing so funds were brought into UCL for extra staff, equipment and travel plus a contribution to overhead costs.

A possible disadvantage is that collaborations of this kind involve senior staff in extensive working periods abroad. So far though this has been more than outweighed by the additional experience gained working in a different laboratory.

(viii) Impediments within the UK to Engaging in ISPs

Concerning the Stimulation-Action Programme, the EC demand that any staff employed on a contract must be recruited from a country other than that in which the work is being performed. This raises the general point of the difficulty of attracting good scientists from abroad into the UK due to the relatively low level of our salaries.

Examination of Witness

Professor Sir Robert Wilson, CBE, FRS, head of Department, The Department of Physics and Astronomy, University College London, called in and examined.

Chairman

575. Sir Robert, thank you very much first for the written paper from you and your colleagues which was of great value to us; and for coming here yourself this afternoon. I think perhaps we asked the previous witness about this question of the balance between national and international programmes and I think the conclusion we seemed to be coming to was that you should not regard them as separate. You yourself in your paper have brought this out and say you need to have an adequate national programme if you are going to get benefits out of the international programme or even participate. As I said to SPRU we get told, first of all, that you must engage in international programmes, perhaps you cannot afford to do it all yourself, and then you say we must have strong national programmes in order to be able to take part in international programmes which may mean in the end you are paying more than you would for a national programme. How do you strike the right balance?

A. I think first of all you have to look at the whole. It is no good saying that this is an international programme and that is a national programme. You have a programme which is a science programme and to pursue that programme you have to do certain things. For the big sciences we have gone into ISP out of necessity because you simply cannot stay at the forefront of the subject unless you do that. It is a necessity although there are other advantages in going into the international programme, such as interacting with people of different backgrounds and different approaches. The real reason, in the case of the major science, for CERN, ESA and others is certainly necessity. When you go in you should really go in and think of the whole UK programme. You have to say what is the contribution that we make to, shall we say, the big establishment; let us take the European institutionalised establishment, either CERN or ESA, you make that contribution, that makes you part of it, you then compete for the use of that facility very often under extreme competition and when you win the slot either on a big accelerator or on the satellite, you have to find the funds to provide the instrumentation, not only the funds but you have to provide the know-how which goes with using those funds. It seems to me there is an obvious minimum level of national funding and that is the level that it takes you to fund the instrument when you win the place. It would be quite silly to say: "We pay our contribution but I am sorry, thank you for that offer but we cannot afford to fill it". That is the minimum level. I say the minimum level because if you only do that then you really do not have control over your science programme. It depends on the peer review committee which happens to think your experiment in that particular area at that time is better than another one. So out of this will emerge a programme but not a programme which is planned nationally, it is what you manage to win. Now you need additional national funds over that minimum level in order that you can maintain a sensible programme, a programme whereby, for example, you can fund the seed corn. If you do not allow the people the development resources in that area but only enough to build instruments, then instruments in the future there will not be because they will not have the expertise. Also, sometimes you need a national programme, which could be purely a national or international arrangement with some other countries, because there is a big gaping hole in the programme because the selection process did not fill it. I have some numbers for ESA, I suspect the situation is similar for CERN, given to the 1988 conference in Capri, all the countries in ESA were asked: "Tell us what percentage of your spend in space science, not technology, do you spend

[Chairman *Contd*]

compared to the total funds you put into ESA, in other words the total funds of your contribution to ESA and the cost of the experiments you fund for ESA". The figures were quite remarkable. The lowest percentage in the whole of Europe was this country, 7%. That means in this country we are making sure we exploit the facility but we are near the brink, if we pushed too far, by exchange rates, we will start reaching the point of not being able to fund the selected instruments. The remarkable thing is that our 7 per cent compares with 67% for Germany and 109% for France. I am not sitting here suggesting the French and Germans know all about space and that we should copy them; all I am saying is a totally different judgment has been reached in other countries. It will take a long time to pursue all the reasons for this but there is a major difference.

576. Apart from the ESA programme, which some of us are fairly familiar with because we studied the space programme, is this happening in other fields?

A. I believe, (although I do not have similar numbers and it is difficult to get those numbers, they are there because ESA asked the different countries) that in particle physics it is a similar kind of situation where it is funded sufficiently to be able to instrument these facilities. It strains particle physics in the Universities who cannot afford sufficient research fellows because they do not have the funds. The academic scientist has to come back to teach, which is just as important, some people say more important, than doing the actual research. I have a feeling in particle physics that it is a similar situation where we are funding at the level which I have defined as minimum level.

Lord Dainton

577. Is Professor Wilson saying that really we are just not getting value out of the international facility for the capital costs for which we provide because we are not spending enough year by year?

A. No. I have to explain. It happens that in both of the organisations we are discussing, in space and particle physics, were set up when this country was undoubtedly the strongest in those two science fields and now we are riding on the inertia of that. What I am saying is if we continue in this way then in time, indeed, Lord Dainton, we will not get value for money because the scientists will no longer be able to maintain their expertise.

578. Those like France who are paying 109% of what it is you said or Germany at 80 something per cent, are they getting value for their money at those high levels of annual national expense or is there a point above which it starts to be unproductive?

A. First of all, I said I would not defend those judgements, but only that somebody has made those judgments.

579. It will be interesting to know your views.

A. I feel reluctant to try and judge the whole of the French and German particle physics and space science programmes against their levels of funding. They are good but, for sure, if you look *pro rata* they are in the case of space science, it cannot be said that the French programme is 15 times better than the UK.

580. Is there a kind of optimum percentage that we ought to be aiming at to get the maximum out of that money which we have already invested?

A. Yes, I am sure there is but it is a matter of judgment what that is. I would say, being rather simple minded, if you have national funds to exploit the facility you should try and take the same amount again in order to have the flexibility to prepare your science for the future and to fill those holes. That is my judgment.

581. Your view?

A. Yes.

Lord Lewis of Newnham

582. I think somewhere—I am sorry I cannot put my hand on it—in this report you wrote there is a remark: "We are in danger actually of subsidising countries in the use of these instrumentations because we have not got the extra money to utilise them to the degree we should". Would that be a fair statement?

A. The remark was made in the context of the reduction in the national part of the budget due to pressures of GNP and exchange rates and so on. It said if the policy adopted, which was that the research council had to bear this entirely, then in the end the ultimate result could be that. The number I have given you for the ESA would imply we are not far away, since we are only providing 7 per cent of our total expenditure in space for the national programme. We are not there yet but we could get there before too long.

Lord Nelson of Stafford

583. I would like to ask Sir Robert: in his report he refers to the advantages of hosting large facilities. We do not host very many facilities, in fact, but you point out the very good advantages that have come out of that. Do you think the decisions to host or not to host are wisely taken? Are they thoroughly examined before the decision is taken?

A. Not in this country. I do not mean to imply it is in other's but I suspect it is. The hosting of a large facility gives a country not only the science advantages which you can identify, there are other advantages. Economically, you can count out the salaries of the people who will be employed and spending the money if you have it. The stimulation for industry, you could get some idea from the technological industries dotted around CERN because of its stimulation. So I believe there is a wider factor than the pure science one.

[Lord Nelson of Stafford *Contd*]

The Science Research Council sit down and negotiate: they do not say "Oh, yes, but it is good for politics in the UK or the local economy"; they have a budget and they have to do things within that budget. Other countries do things which I think we should possibly consider and that means widening the dimension of the discussion and not just leaving it to the scientists.

584. Who should do that? I rather get the impression we do not do that along the lines you mention.

A. We do not do it. I can say what should be done and that is a simple calculation of what is the economic advantage, we make an estimate of technological stimulation and then we can give preferred terms in order to get the facility in this country. This is what other countries do—for example, give them an acre of land and charge a peppercorn rent.

585. Of the individual agency does not get those advantages, it merely foots the bill and says: "We cannot afford it"?

A. Science has to be the most important element but in addition to that I think a wider view looking at UK Limited might be a sensible thing at that stage.

586. Who do you think might do that?

A. I do not know. It has to be, obviously, wider than SERC which, is not a political or economic organisation. Perhaps some wise person from the House of Lords can do it!

Chairman

587. Both on Lord Nelson's subject and the one we were discussing just before, you could put the other point of view. You could say that with France spending the amount it does on space, by making a minimum contribution to take part in the mandatory programme of ESA and a small bit of the optional programmes we are gaining from all the effort that France has put into space. I am just putting the Treasury devil's advocate into it. You could also, from the point of view of hosting, say, take much the same argument. If you host something, take JET for instance, you are inextricably left with it as long as it runs and then when it is finished you have got to clear the thing up, you cannot escape from it under any circumstances. Again, you could say that in a way if you do not host one of these should you take part in it because the person who is hosting it is, to an extent, subsidising the others. Do you think those are arguments which are not valid at all?

A. They are valid but it is a matter of judgment on the advantages which I have outlined again in that particular argument. My view is that hosting is undoubtedly the greater advantage because if France has put a lot of money into space and if that helps ESA we will have some help from that, but simply to give up any kind of real control over the future space programme and leave it up to France and Germany is a very heavy penalty to pay for a return of some technological stimulation.

Lord Sherfield

588. You say somewhere that UK industries are extremely reluctant to tender for the equipment of commercial co-operative programmes and that was notorious in the case of CERN. Have you seen any proof in the case of ESA?

A. The two situations are, in fact, quite different. The remark was made in the particle physics section and it referred to CERN and not to ESA. In the case of CERN there is some great reluctance and you should ask the industry why, but the story we hear is that the particular demand of technology for CERN is on heavy engineering with tremendous accuracy which is more appropriate to industry which is heavily involved in defence and in this country MoD operates by cost plus contracts, whereas CERN adopted fixed cost contracts. We were told one was easier and more lucrative than the other, whether that is true or not I do not know but that is what is said. ESA is totally different. CERN does not have the *juste retour* principle but ESA does. In the case of ESA the UK industries have been able to win contracts and the problem for ESA is to hold UK industry down to its *juste retour* limit. I think the reason for that is that in space in Europe the lead country in the 1960s—and I mean lead by a long way not just in front of almost any other country—was the UK; we made rockets, for example, and also put the first satellite into orbit other than the United States and the Soviet Union.

589. These are the Ariel series?

A. The Ariel series. These were made by British industry. When ESA was formed, *juste retour* restricted returns to this country and we would have been much better with it the other way: *juste retour* for CERN, no *juste retour* for ESA! The circumstances are totally different.

Chairman

590. Have you got, Sir Robert, any suggestions to make about how we should get over these difficulties? First of all the difficulties connected with a combination of underestimating inflation and also the fluctuation of exchange rates, which is slightly different from the problem of attribution, and the two together are causing a great many people a great deal of concern. Have you any golden solution which would make it all right?

A. No, but perhaps some comment. The reason why the fluctuation problem, and let us take CERN which was a severe example against the Swiss Franc and the movement os GNP in the UK, was simply that the perturbation was too big for SERC to accommodate it. If you have a perturbation you have to be big enough. If the perturbation swamps you it is very difficult and SERC is not big enough.

[Chairman *Contd*]

You need a bigger buffer. The other countries had it by using a major Department of State, such as the Foreign Office. I would be very unhappy to see that buffer become the Foreign Office or the Treasury, or anything like that.

Lord Dainton

591. It could become the unified research council?

A. If it is big enough. It might have to be the whole DES or the whole science budget but you have to reach a point where the buffer becomes big enough for the perturbation to be absorbed without causing tremendous damage. The money still has to be found from somewhere but that is alright as long as the fluctuations in time smooth out. The difficulty is for some time now it has been going one way and it would be wrong for the scientists to ask whether, while it is going one way only, it can still be accommodated by somebody else. If it is going one way there may be some long term plan to grasp that situation, but how that would happen I do not know.

592. What about the effect of attribution on the Research Council's budgets?

A. The non-indexation problem?

Chairman

593. No, the Treasury's principle of attribution. This applies only to the European framework.

A. Yes, sorry.

594. If the programme develops beyond what had been originally estimated and if an extra cost is attributed to the Research Council concerned?

A. First of all, let me say that has not hit my Department very much and this is a Departmental submission. We can only tell you what we know and have had experience of. As yet we have not got a lot of EC contracts, we are now trying to do so. I think it is just plain silly. If you go through the EC system, the bureaucracy and the paper work is staggering, it is quite frightening, it is bad enough in our own country. If you say: "Here is a route but a far more difficult route and if you win anything at the end of the day we will take it away from you" it is an obvious impediment to scientists in this country trying to go there. We should say to them: "That is marvellous, we have more EC funds in this country, that is our reward" and leave them where they fall.

595. On another subject: do you think there is a serious brain drain from this country into Europe because of the salary itself and not only to Europe to elsewhere which is not counter-balanced by people coming back?

A. Again, I do not have any statistics but I do not think it can be said to be serious. What I think is serious is the danger that it may become serious because we have a situation, for example, in the EC contracts, like the stimulation scheme which we have won in the Department, where you get money also for staff but, the rule is you cannot employ anyone from your country. I agree with that, it is a political reason, but you have to pay the salaries of the country you are in, so on this we find it almost impossible to get a German or Dutchman to come over on a British salary. But, of course, when that contract takes place on the continent and a British person is offered a job, he says "Oh, my goodness" and he sees he has been offered a salary far higher than into this country. So there is a tendency to impede the progress of such scientists in this country but to encourage the employment into others. Ireland is an exception.

596. Ireland is an exception?

A. But the interaction is very small.

597. What about this problem of the complications of research, fellowships being complicated by, in our case, having a teaching responsibility as well?

A. I personally am strongly in favour of everyone doing research also doing some teaching. If you really want to learn your subject get in front of fifty young clever people and lecture to them and then try to cope with the questions. It really makes you think. So it is not just a contribution to the institute of learning these people make, it is a contribution to their own training. I think you could spend 10 or 20 per cent of your time teaching and not in any way say: "Well my research has suffered". So I am personally strongly in favour of it.

598. You would not be in favour of trying to see that more researchers who are involved in international programmes should be relieved of teaching responsibilities?

A. No. Certainly you should not reach the point when you have more teaching than research, you have to get the balance right, I would have thought 10 or 20 per cent of time in teaching is very sensible, in fact the optimum I would say.

599. The two major complaints we have had out of the evidence were, first of all, in the top-down big projects it takes an awful long time to get a decision as to whether we are going to participate or not—this is particularly in projects which cost so much that they are above the level of decision of a single research council—the other is the bottom-up one that there again where people have found the nucleus for an international collaborative programme and you put the thing to the research councils, it then takes a very long time again to get an answer and meanwhile it is very difficult to hold the prospective collaborators together. Do you think these are valid criticisms? If so, where do you think the fault lies? Is it in the research councils or outside or where is it?

A. Certainly it is a very valid criticism. A decision taking time now for some major projects has spread to several years and, of course, if you see the young

[Chairman *Contd*]

scientist who is going to be the one who is going to do it all ten years from now ,who enters the project and finds it is five years to a decision and another five years to completion, ten years is too long. So, we will lose those scientists. There is no doubt the criticism is valid. As to how or why it is, I do not know. If I take the example of the European Space Agency, there they start off by inviting proposals, often with a defined objective, and these are assessed and that takes up a whole year and after that they start having design studies for this process, another year, and after that they select a few for phase A studies. The last such process in ESA was one in which four were taken through phase A studies, four, in order to pick one. There is a strong tendency for some major organisations to like to have lots of paper work, lots of proposals, lots of competition and so on. My experience is it is always worse in an international body than a national body in this particular context. All I can say is I see it happening but I cannot explain why it happens but it is important to try and stop it and to shorten this decision taking process.

600. That would appear to be an argument against international collaboration. Is the answer to that not then to try to stick to national programmes as much as you can or to engage, as happens in your own field, in direct bilateral or trilateral arrangements?

A. No, I would not accept that. I think the argument "it is more difficult therefore we should not do it" is not a good one. We have to solve the additional management problem that you have in an international organisation compared to a national one. That is the only way to go about it, to solve the problem but not to avoid it which is what you do if you say: "Let us go national". The United States does not have the problem of saying: "We have to get all the councils in the States in the US together". If we all went national there is no doubt at all we would go third class in Europe very rapidly.

601. Instead of ESA you could have a French national programme with which the British and Germans collaborated, could you not? Would that not produce a better answer?

A. It might, yes it might. There are different ways of having international collaborations. You do not have to institutionalise them. There are several in the Department, for example three countries get together, they agree their objectives, agree what to do, how much to pay and do it. I have to say—I had better clarify it after I have said it—my experience is these multi-national projects are better, smoother and that the camaraderie is there much more than in the institutions. I believe that is true, but not because one method is better than the other. I suspect we have not yet developed a European international institute in the best possible way.

Lord Nelson of Stafford

602. In your section on ground based astronomy you refer to the fact the application of the AAO method of administration by Hawaii and La Palma would be a better way of operating. Why do they not change the method of operation if there are such advantages to be had as you indicate.

A. Yes.

603. Who should make the decision to change?

A. I smile because it is a slightly delicate area. Let me explain first the different ways of operating. In the case of the AAO, the AAO has total management authority for the observatory. It has two paymasters. It has to convince them they have to give the money but when they have the money they have total authority. They have two telescopes up on the mountain and they have the base camp in Sydney staffed by fifty people.

Let me now take JCMT. I happen to be Chairman of the Board of the James Clerk Maxwell Telescope which is a 15 metre diameter radio telescope operating in the sub-millimetre range which is the highest radio frequency you can get to. There are four countries involved, the UK (who designed and built it, at RAL, and this telescope has been awarded the MacRobert Award, the highest engineering award you can get in this country), the Netherlands, Canada and the United States because it is on US territory. The management Board was formed with representatives from all of those countries, which was a jolly good idea, and I happened to be elected Chairman of that Board, but a dispute arose, and is still continuing, between the Board and SERC about the nature of that Board. The SERC top management claim the Board is advisory, and, therefore, it is SERC who manages it so they will manage it and let us know how they are doing and so on. All the members of the Board, the UK, Dutch, Canadians and Americans, disagree with this totally and the other partners say their agency believes it is a management Board. They say: "We give you the money, go and manage it", so we have this dispute. If JCMT moved towards the AAO model we can do so simply by the agencies agreeing that that board has management authority which means full control of the budget and resourses. Thus the management Board might say, and they have already said this: "We do not like the idea of having a team of JCMT located on Blackford Hill, we think they should be in Hawaii." SERC say: "We want our people up there in Edinburgh to do this job". That is why the conflict is delicate, it is linked to actual SERC establishments in this country.

604. Not to touch on the Americans or Canadians?

A. Not them.

605. AAO has gone on?

A. There has been a change of chairmanship within SERC and my letter to the new chairman may result in a resolution of this but there has been a

[Lord Nelson of Stafford *Contd*]

major difference of view. The other thing is the cost effectiveness of AAO which operates with 50 staff in one place. The two other observatories also have a facility on the mountain, they also have a laboratory at the base of the mountain which each have about 50 staff. But in addition to that each has another establishment, one of the Royal Observatories, in this country and many astronomers have said at some time, and I am one of them, it is quite unnecessary to have two establishments in this country to support observatories when the observatories are elsewhere. The Royal Observatories are not observatories, they are establishments, they do not observe anything, the name is entirely historical and we should recognise that. There is a great belief we could make the whole process more cost effective by reducing the number of establishments in this country to one. The AAO gives a perfect example because it works. Everyone says the Anglo-Australian telescope is the best instrumented optical telescope in the world and it does not have a big establishment sitting in the country.

Chairman

606. Would you like to comment on the differences in collaboration between Europe, the United States, Japan and the Soviet Union?

A. Yes. From personal experience I cannot actually comment on all those relationships although, in fact, all those relationships exist within the Department and they do vary considerably. The first thing I think I should say from experience is that when you have an international collaboration it is essential for every party to recognise that the others have different systems, different regulations, different timescales for decisions, and unless you adjust to this you will not get very far. The collaboration with the Soviet Union is possibly most difficult, not because of the people involved but because of the system although that is improving all the time, but in the past if you collaborated with the Soviet Union you probably would not know anything that happened on the other side and that was a great disability. Between Europe and the United States it is difficult to compare because there is no doubt that we in this country seem to be able to collaborate with, and mingle with, the Americans better than many of our Continental Europeans, that may be the common language, but I really do not know. We have in the Department, particularly with the United States, several collaborations which are unbelievably successful, more successful than those we have had through the European Space Agency. The IUE was an American UK venture in which we invited the European Space Agency to enter and it has been one of the most successful satellites ever. President Reagan gave it a very special award at the end of his last term of office and there were only 10 given. The relationships with the Americans are very good. With the Canadians I mentioned JCMT, they are very good. With the Dutch, the British seem to get along exceptionally well, certainly in astronomy, perhaps because we both have terrible climates for the subject? This was not so easy with the other continentals, although language may be a large part of this rather than national characteristics and so on.

607. You would not support what a lot of people say, that in attempting to collaborate with the United States they tend totally to drive the programme and you do not get enough influence in it?

A. My own personal experience, which is very extensive with IUE, is to the contrary. IUE was a British proposal and it may have been because of that, of course, being a British proposal, that the Americans decided to adopt it and they picked up most of the cost. But we made a very strong intellectual contribution and it may be because of that we got an unbelievable deal from the Americans. Our contribution in monetary terms, not intellectual terms, was about 7 per cent. We got 15 per cent of the observing time and we had a seat on the management committee to participate in the main decisions.

608. That was because we had a strong base in this country?

A. Yes.

Chairman] Unless my colleagues have any other questions thank you very much indeed, that was very helpful, we are very grateful.

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